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A Comparison of Deaf and Hearing Students

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Abstract

This word association study compared the primary associates given by deaf college students with those from a set of hearing norms. Forty common words were selected from the norms; twenty category names for which the primary associate was an exemplar (or member of that category) and twenty exemplars for which the primary associate was the category name. Overall, deaf students showed a similar pattern of responses to the hearing norms, although the strength of the primary associates for the deaf students was not as strong as for the hearing students. Comparing responses to the two groups of stimuli, hearing students were far more consistent going from category names to exemplars than the deaf students, while there was no significant difference between the two groups going from exemplars to category names. Relations between reading scores and patterns of responding were analyzed, and higher scores were found to be associated with a greater consistency with the hearing norms.

Introduction

Reading requires that the reader knows what the words on the page mean, and much more. To say that a person "knows" the meaning of a word implies a host of cognitive abilities. After a word is processed visually, the meaning of the word must be retrieved from memory (Fischler, 1985). To create and retrieve representations involving familiar words, preexisting associative structures must be linked (Nelson, McEvoy, & Schreiber, 1998). These structures rely on past experience, and conceptual understanding of printed words demands this activity. If the knowledge inherent in the lexicon is important for achievement in reading, then an assessment of its structure in deaf students should aid in improving reading through targeted instructional methods (Marschark, Lang, & Albertini, in press).

Reading involves making associations between words, taking into account the context and multiple meanings of words. Knowledge is organized schematically into what is known as semantic memory (Kretschmer, 1982). Words have a dynamic associative structure in memory that involves not only individual representations of the words, but connections to other words as well (Nelson et al., 1998). If the integration between words and context is not accomplished, reading becomes ineffectual (Fischler, 1985).

The task of reading can be analyzed through top-down and bottom-up processes. In top-down processing, readers generate hypotheses using knowledge that has been developed through experience and exposure; in bottom-up processing, readers focus on analyzing text in terms of the printed page (Pearson, 1982). When words (coupled with syntax) are not easily comprehended, students must rely more on top-down processing, trying to make sense of the passage using what they already know. This word association study directly relates to this strategy by testing the kinds of immediate top-down, conceptual connections readers make while reading.

For many deaf students, reading is a formidable task. The Stanford Achievement Test (SAT) has consistently measured the national median reading score for 20-year-old deaf students at a grade equivalent of 4.5 (Strassman, Kretschmer, & Bilsky, 1987). Results from the 9th edition of the SAT confirm this assessment. The median Reading Comprehension scores, by age, for the entire group of deaf students in the norming sample fall largely in the Below Basic area (4th grade and below) (Traxler, 2000). Understanding the associations among lexical concepts in deaf students may help to determine methods to combat this disheartening statistic.

In this study, comparisons of variation in word associations were made between deaf and hearing students, and among deaf students, variation as a function of English skill. Reliable as a testing method, word associations are used to index abstract comprehension and retrieval processes that need tangible evidence to be studied (Nelson et al., 1998). If deaf students reveal an organization of individual concepts that is markedly different from hearing students, it would suggest that weaker or different semantic connections can impede the ability to comprehend those words in text.

A review of the literature will provide a theoretical framework and describe several studies that relate to word associations. Following the review, the method and procedures are outlined. The literature review is divided into four subsections: 1) reading development, 2) memory structure, 3) schemata, and 4) word recognition and context.

Literature Review

Reading Development

When vocabulary level is tested, deaf students lag far behind their hearing peers. It has been reported that at the level of the 2000 most frequently used words in printed English, 14-year-old deaf students perform at only a 60% accuracy compared to their hearing peers (Walter, 1978). It is unfortunate that for many deaf students, there is little improvement with time. Working with the SAT, 9th edition, Traxler (2000) examined the Performance Standards study sample which represents a subgroup of deaf students (percentages vary with age) who were judged by their teachers to be on or near grade level with their hearing peers. It is interesting to note that while 99% of the 8-year-olds in the norming sample were included in this subgroup study, only 10% of the 15-year-olds were included. This appears to support the claim by Kyle (1980) who reported that by the age of 15 or 16 years, the average deaf person reads poorly and a significant portion do not read at all.

In the early stages of learning to read, there appear to be no consistent differences between deaf and hearing students (Fischler, 1985). Kyle (1980), for example, showed that deaf children at age seven have reading vocabulary comparable to hearing children; by age nine (4th grade), however, profoundly deaf children have barely begun to read for meaning and are lagging behind hearing peers. At low reading levels, comprehension frequently is limited to factual recall (Strassman et al., 1987). If reading skill begins to level off around the 4th grade, it may be because it is around this time that students must begin to read to learn, a major cognitive leap from learning to read. Also at this age, a significant increase in vocabulary concepts becomes necessary for reading comprehension (Kyle, 1980).

Vernon (1972) found that deaf students between 10 and 16 years of age gain little more than 0.1 grade level per year in reading achievement (Marschark & Harris, 1996). Educators who have low expectations of deaf students may be part of the problem. Hearing children are expected to steadily improve their reading skills with each passing year (but the number of students who actually graduate from high school with a "12th grade reading level" is questionable). The Performance Standards study that compared deaf students who perform at grade level with hearing peers found that approximately 60% of both hearing and deaf students achieved no higher than level 2 (Basic) in Reading Comprehension (Traxler, 2000). Hearing children, however, have greater access to incidental learning opportunities.

Deaf children who struggle with communication barriers at home are affected by impoverished language abilities. It follows that world knowledge may be severely limited, and fewer things are labeled with words due to a language deficit (Marschark & Harris, 1996). Readers need to actively construct meaning from passages, and this is a function of their world knowledge (Kretschmer, 1982). There is a kind of gestalt experience during the complex task of reading.

Other studies have reported that deaf people are restricted in terms of breadth and depth of vocabulary functioning (Walter, 1978). While there is greater heterogeneity of reading skill among deaf students than hearing students, deaf students generally have smaller vocabularies and are more likely to understand and use concrete nouns and common action verbs (Marschark & Harris, 1996). They have less exposure to a more sophisticated lexicon and, therefore, less experience with abstract links that stem from literal definitions. Limited word knowledge is at least in part a product of limited world knowledge. Experience with words, as it will be seen later, is a critical factor in determining how deaf students perform on a variety of cognitive tasks that involve linguistic skills.

Memory Structure

Highly developed memory skills may be especially critical for deaf students because much of the English language information that is acquired incidentally by hearing people must be learned and memorized by deaf people (Krinsky, 1990). One way to investigate the lack of English proficiency is to look at how memory is organized. For vocabulary items to be learned for later use, they must be transferred from working memory to semantic memory, which is structurally complex (Akamatsu & Fischer, 1991).

A study conducted at NTID by Akamatsu and Fischer (1991), for example, required deaf students to recall words from five different list types: random words (e.g., CLEAN, RED), semantically similar words (e.g., KIND, GENTLE), semantic pairs (e.g., HARD-SOFT), scrambled sentences (e.g., OF FEAR WEATHER PEOPLE FOUR OUT FIVE BAD), and grammatical sentences (e.g., THREE GIRLS PLAYED LOVELY MUSIC LAST NIGHT). There were 30 lists (6 lists of each type), of 8 words each.

Results showed that deaf students with higher English levels had better recall than students with lower English language levels, most notably with semantic pairs and grammatical sentences. When lists have an order or an organizational structure they are remembered better, and students with higher English skills are better equipped to benefit from such organization. Greater lexical organizational skills are facilitated by greater English skills and vice versa.

This type of direct testing method is related to "explicit" memory functioning, which is used when subjects are asked to intentionally recall or recognize information after a study phase (Nelson, Schreiber, & McEvoy, 1992). Such tasks can be contrasted with "implicit" memory which affects current performance by calling up a cache of previous experience. A *Twenty Questions* game is an example of this.

In a problem-solving study by Marschark & Everhart (1999, Experiment 2), NTID students and hearing RIT students participated in a game of *Twenty Questions*. From an array of 42 colored pictures, subjects were asked to deduce which familiar object the investigator "had in mind". Items varied on several dimensions: taxonomic (e.g., "rabbit"), functional (e.g., "saw"), and perceptual (e.g., "clock").

Results showed that the deaf students did not figure out how to use conceptual strategies to be successful players. They asked fewer constraint questions (e.g., "Is it an animal?") than their hearing peers, and cognitive skills (e.g., semantic hierarchies and category names/members) seemed less structured, at least as indicated by the kinds of questions they asked. Fewer informal or incidental learning experiences, due to communication barriers from an early age, was proposed as a possible reason.

In a word association study involving sound related (e.g., RADIO) and non-sound related words (e.g., FASHION), McEvoy, Marschark, and Nelson (1999) found that deaf and hearing college students produced a high percentage of similar responses when asked to write down the first word that came to mind. However, responses from deaf students were far more variable and they were more likely to leave spaces blank, relative to hearing peers. Related to deaf students being stymied in the *Twenty Questions* game, McEvoy et al. suggested that a lack of experience with concepts and individual vocabulary items would lead to students being unable to consistently produce related responses when requested to do so. Again, a lack of incidental learning is implicated.

Schemata

Incidental learning is a necessary part of language acquisition and the memory structure that allows for its development (Yoshinaga-Itano & Downey, 1986). Schemata relate to implicit memories as representations of an individual's experiences and knowledge that have been stored in long-term memory (Yoshinago-Itano & Downey, 1986). Labels are applied to things and members are included or excluded depending on the strength of the schemata which is developed through experience. As Yoshinago-Itano and Downey explain, "birdness" includes flying and examples of birds, and while concepts may overlap, a bird would not be confused with an airplane. Plato would add that we recognize a particular table as a table because it has the Idea of "tableness." Making a connection "upward" to the category name, TABLE is tied to FURNITURE as well as to the various contexts and uses of tables. The schema for TABLE also has a "downward" connection to members: PICNIC TABLE, BUFFET TABLE, POOL TABLE. Schemata are abstract by definition and do not correspond to particular objects or events (Pearson, 1982). A schema for TABLE relates to an idealized table, not to any one, specific type of table. Hence, "tableness."

We recognize the varieties therein because we thoroughly understand the concept and its relations to other concepts. When deaf children have more limited experience with language and labels, the development of schemata is affected, which in turn affects the verbal labels within each schema (Yoshinaga-Itano & Downey, 1986). Schemata are developed and extended (or limited) by world knowledge.

However, Furth (1971) reported that deaf children perform as well as hearing children on cognitive tasks when the background and experiences of both groups are comparable (Tweney, Hoemann, & Andrews, 1974). In a task which required deaf and hearing high school students to sort high-imagery (e.g., SKY, PRISONER) and low-imagery words (e.g., MEMORY, EXCUSE), Tweney, Hoemann, and Andrews reported that the performance of deaf students was comparable to that of hearing students. From this study, it appears that semantic structures of deaf and hearing students are similar; differences are related to experience (or lack thereof) with particular words in different contexts. Prior knowledge explains variance in comprehension more than reading ability as measured on tests (Pearson, 1982). This suggests that vocabulary "knowledge" in and of itself is not enough. Without the ability to apply vocabulary to different schemata, facility with words will be severely compromised.

Since Tweney et al. did not find a significant advantage for deaf students in high-imagery words, they concluded that conceptual processes (for both hearing and deaf) are not tied to visual (or acoustical) channels. This was confirmed by McEvoy et al. (1999) when it was shown that the mental lexicons of deaf students and hearing students are similar for non-sound words (e.g., CRYSTAL, PICNIC) and sound words (e.g., BUZZ, HUM).

Schemata organize characteristics that lead us to confidently call something by name. The process of filling slots (or calling something by name) is known as *instantiation,* from the word, *instance* (Pearson, 1982). In a study that focused on instantiation, the success of sentence recall was found to be influenced by the type of semantic cue (Strassman et al., 1987, Experiment 2). Presented with semantic cues for sentences that were either particular (the instantiation, e.g., SUBMARINE) or general (the subject noun, e.g., SHIP), deaf high school students were asked to recall the related sentences. Using sentence triplets such as, *The ship sailed across the water* (control), *The ship moved underneath the water* (target), and *The submarine moved underneath the water* (exemplar), results showed that of the correct responses, exemplar sentences were recalled better (36%) than control (20%) or target sentences (22%). However, overall, only 27% of the cues were responded to correctly.

Strassman et al.'s (1987) Experiment 1 showed that students were able to recall the instantiation for target sentences at a rate of 70% when directed to do so. For example, given the sentence, *The ship moved underneath the water,* students were able to recall SUBMARINE. However, failure to independently connect these instantiations with sentences in Experiment 2 indicated weak or incomplete associations (Strassman et al., 1987). For example, when given SUBMARINE (the instantiation), students failed to recall the sentence, *The submarine moved underneath the water.* Exemplar sentences, such as this one, were in the category of highest recall (36%), but overall performance in this category of sentences was nevertheless poor. This is not surprising since the information that the average deaf child of hearing parents acquires incidentally is likely to contain many bits and pieces, and the child either fills in the gaps by making appropriate (or inappropriate) inferences or simply stores inaccurate or incomplete information (Yoshinaga-Itano & Downey, 1986). Tying together the processes, making inferences is an essential part of schema selection and instantiation (i.e., filling a slot from one's schema), and reading requires making inferences (Pearson, 1982).

Word recognition and Context

Readers must continually connect words and make appropriate inferences if meaning is to be comprehended. While weaker readers rely more heavily on context for understanding, for skilled readers, word recognition is rapid and automatic, leaving little time for contextual analysis (Fischler, 1985). The more effort spent on word recognition and other bottom-up processes, the less attention readers spend on overall comprehension, since processing capacity is limited (Kretschmer, 1982). Reading and even comprehending individual words will not necessarily lead to comprehension of a passage.

Fischler (1985) used incomplete sentence contexts in a study that included Gallaudet students and hearing students from the University of Florida. The contexts were 6-12 words in length and needed only a single word for the completion task. Students had to decide if an item that completed the sentence was a word or not a word (e.g., BLARK). To illustrate the task, students saw the unfinished sentence, "The child tried to open the ..." and were told they may see JAR, or ROOF or a nonword like DRIM. Response times were tabulated. In a separate condition, words were also presented in isolation.

Results showed that deaf students were significantly slower than hearing students to decide if the string was a word in both the sentence and isolated word conditions. There was no difference in error rate in the neutral (isolated word) condition, suggesting that individual words may be recognized as meaningful, but become more challenging as deaf students (needlessly) rely on context for a decision. Deaf students responded to primary (most likely) completions more quickly than to words that were acceptable (qualifying as words), but unlikely completions. Context thus appeared to be used as a cue, which led to unnecessary associations that disrupted comprehension of the strings. As a study by Wolk and Schildroth (1984) documented, students routinely completed sentences by erroneously associating a word in the item stem with a response.

The types of responses deaf students give to word associations may be related to why the same wrong responses to standardized reading comprehension items are commonly chosen by deaf students. Wolk and Schildroth (1984) analyzed responses of 1900 deaf students who took the SAT (Primary 2 level), which is comparable to a seven-to eight-year-old reading level in tests for hearing students. A word association strategy appeared to be used between words or ideas in the text and the chosen responses. For example, when students were presented with, "Jim likes to PLAY more than he likes to go to __________," the detractor, "the park" was chosen 2.5 to 1.0 over the correct response, "school." Data suggested an extraordinarily consistent use of this kind of associational response.

Reading requires making connections between words, and there is a symbiotic relationship between text and what resides in the reader's head. Semantic networks appear to be similar between deaf and hearing students; the development of cognitive skills that are related to reading and vocabulary building seem to be associated with background, experience, and world knowledge.

Study

To investigate the organization of the lexicon, this study focused on word associations made by deaf students. The responses of the students were compared with norms representing hearing college students.

The questions of interest were: How well and often do the responses of deaf students match the responses from the hearing norms? Is the lexical organization the same or different from hearing students? The norms that represented hearing students included items that yielded as their primary associates 1) exemplars (members of the respective categories) for category names and 2) category names for exemplars. Thus, the primary analysis was two-fold: 1) the frequency with which deaf students gave category names as the primary associates of exemplars from the hearing norms, and 2) the frequency with which deaf students gave exemplars as the primary associates of category names from the hearing norms. In this study, I was interested to see if there would be a difference in response rate and quality between category names and exemplars given by deaf and hearing students and the extent to which deaf students' patterns of responding were related to their reading levels.

Method

Participants

The participants were 126 deaf students from the RIT community. Five additional participants were excluded due to insufficient data. To be included in the study, responses were required for at least 20 of the 40 words. The sample included NTID students and students who were cross-registered into one of the other seven colleges at RIT. The majority of the testing occurred in group settings (i.e., classes and meetings) with the intention of including a broad representation of the student population. Responses were compared to those of hearing students at the University of South Florida who participated in the normative study (Nelson et al., 1998). To be able to compare responses with reading ability, a signed consent form allowed access to RIT/NTID entrance test scores.

Materials

The stimuli were 40 common English words selected from the University of South Florida (USF) Word Association Norms (Nelson et al, 1998). The norms were collected from more than 6000 participants and produced responses to over 5000 stimulus words. To collect the data, USF students were given booklets containing 100-120 English words. Next to each word was a blank space; they were instructed to write down the first word that came to mind that related to each word. For the purposes of this study, the 40 words selected were 20 category names for which the primary associate (from the USF norms) was an exemplar in that category and 20 exemplars for which the primary associate was the category name. All of the students received the list in the same order.

Procedure

Forty typed words were listed in two columns; the 20 category names and 20 exemplars were randomly distributed. There was a blank space next to each word, and students were instructed to "Print the first word that comes to mind."

In addition to tabulating the responses, three additional scores were tabulated. When students finished, they were asked to circle words they did not know. Also, responses that were illegible or incomprehensible were tallied. A third score was assigned for spaces that were left blank due to subjects not being able to associate certain words with responses. (Presumably, they were familiar with these words.) Additionally, a tally was kept for the number of circled (unknown) words that nonetheless evoked a response.

Although the activation of related associates is normally thought of as automatic, these associations can be inhibited (Nelson et al., 1998). Taking this a step further to emphasize broader applications, semantic representations of individual words may be possible, and yet the strength of the associations among and between the words may not be sufficient enough to lead to comprehension (Strassman et al., 1987).

For the primary response to each of the stimulus words, the strength of the association was calculated proportionally to the number of students who responded to each word. Some deaf students did not respond to all of the words, and a few of the same words were indicated by many students to be unfamiliar. To make a fair comparison with the hearing norms, a proportion of the total number of deaf students was used, depending on the number of responses for each stimulus word. The strength of the associations for deaf students thus was calculated by dividing the number of "matched" primary associations (relative to the hearing norms), by the number of valid responses. The "valid" responses were the total number of students (126) minus the number of words that were circled (not known), left blank, and discarded. For example, for the category name PASTA, 32 students responded with the "hearing" primary associate, SPAGHETTI. One student circled the word and two left it blank, leaving 123 responses considered as valid. Thus, 32/123 equals a primary response strength to SPAGHETTI of .26.

Results

The first-level analysis of the study compared the primary associates given by the hearing norms with the primary associates given by the 126 deaf students. The 20 category names (e.g. PASTA) from the hearing norms had been chosen from among those for which exemplars were given as the primary associates, and the 20 exemplars (e.g. CANARY) had been chosen from among those for which category names were given as the primary associates. Overall, deaf students in this study showed a similar pattern of responses to the hearing norms. The correlation between hearing strength of associations and deaf strength of associations (see Table 1) is significant at $r(38) = .64$, $p < .01$. Word associations of higher strength in the hearing norms, however, were also stronger for the deaf students. At the same time, however, strength of primary associates for the deaf students was not as strong as for the hearing students, $t(39) = 3.316$, $p < .01$.

Beyond the overall results, data were analyzed by separating the exemplars from the category names. Did the overall responses to one group of words (exemplars or category names) parallel the hearing norms more closely? Consistent with the hearing norms, the primary associates given by deaf students were stronger from exemplars to category names, than from category names to exemplars. Results show that there is support for suggesting that deaf students' semantic connections are not as strong as hearing students in going from category names to exemplars, even though they follow the same pattern, $r(18) = .59$, $p < .01$. The difference between the deaf and hearing students in the strength of primary associates was significant going from category names to exemplars: $t(19) = 3.030$, $p < .01$. Related to the strength of the associations going from exemplars to category names, there was no statistical difference between the deaf students and the hearing norms, $t(19) = 1.677$.

Of the primary associates given by deaf students, only ten stimulus words matched the primary associates of the hearing norms with at least a .50 strength or higher. In addition, only nine stimulus words matched the primary associates of the hearing norms with at least 50% of the deaf students ($N = 63$) giving the same associate. Only two of these nine words were category names, and seven stimulus words were exemplars.

In the hearing norms, fourteen words had a strength of .50 or greater. Of these, seven were exemplars (equal to the deaf students) and seven were category names (over twice as many as the deaf students). Thus, presented with category names, deaf students were not as consistent, nor their primary associates as strong as the hearing norms in the likelihood of responding with exemplars. This supports the general conclusion that the deaf students were more similar to the hearing students going from exemplars to category names, than the reverse. Of the 40 associations that were compared, deaf students who responded to the words matched the primary associates of the hearing norms for 35 of the 40 words. For three category names that did not match, other exemplars were the primary associates: MACHINE:COMPUTER; TRANSPORTATION:BUS; and SEAFOOD:SHRIMP. For hearing students, the corresponding primary associates were WASHER, CAR, and FISH, respectively. The fact that only 2/125 deaf students responded with the hearing primary associate of WASHER may be related to the environment (a Technical Institute) and/or the present computer age.

The primary associates of two exemplars were not category names for those exemplars: AFRICA: COUNTRY and LEOPARD:SPOTS. For AFRICA, only 12 students responded with the primary associate, CONTINENT, but 38 responded with COUNTRY. It cannot be known if the confusion relates to the concept, i.e., responding with COUNTRY because they believe it is a country, or if they *understand* Africa to be a continent and are not familiar with the word CONTINENT. Nonetheless, only 12 students responded with the primary associate, CONTINENT.

Additionally, the deaf students matched the exemplar of DOG for the category name ANIMAL (as in the hearing norms), but an equal number also responded with the exemplar, CAT; deaf students matched the exemplar SNAKE to REPTILE, but an equal number also responded with the exemplar, LIZARD. Finally, the correlations showed that the tasks of generating category names from exemplars and exemplars from category names were related, $r(113) = .45$, $p < .01$. While overlap in the skills set is significant, the tasks are discrete operations, as evidenced by their sharing a variance of only approximately 17 percent.

<u>Relations to Achievement Scores</u>

English and Reading scores were analyzed from the American College Test (ACT), the Scholastic Aptitude Test - Verbal (SAT), the Michigan and California tests, and the NTID Reading and Writing tests. Not every student had scores from each test; the ACT, Michigan, California, and NTID tests were most common, and the SAT scores were least common. Scores were not able to be obtained for three students. Correlations between students' reading scores and the frequencies with which their responses matched the hearing norms indicated that higher reading scores on the California test, $r(100) = .208$, $p < .05$, and the NTID Writing Test, $r(101) = .20$, $p < .05$, coincided with a higher number of primary associates consistent with the hearing norms (NTID Reading Test, $r(88) = .206$, $p = .05$).

Correlations from the Michigan, California, NTID Reading and Writing scores also support the reliability of student responses. The higher a student's scores, the fewer number of words were circled as "unfamiliar." These students achieved higher scores on tests that rely on reading and, therefore, vocabulary knowledge (r's = -.68, -.57, -.70, -.34 respectively).

As noted above, deaf students' semantic associations were stronger from exemplars to category names. Related to the correlations from reading and English scores, the higher the Michigan score, the greater was the likelihood that, in response to an exemplar as a stimulus, a category name was generated, $r(93) = .28$, $p < .01$. In generating exemplars from category names, the correlation approached significance. However, the number of exemplars given correlated with the number of words circled as "unfamiliar", $r(63) = -.25$. It may be that the ability to generate exemplars is the more sophisticated of the two tasks. As such, this supports the connection between word association skill and higher-level language skills.

Discussion

The purpose of this study was to investigate the lexical organization of deaf college students relative to that of hearing peers. Reading requires hierarchical knowledge of categories of words. By asking students to respond with the first word that comes to mind, it was believed that an assessment of semantic connections could be analyzed and interpreted in regard to their role in reading (McEvoy et al., 1999).

Deaf students matched the primary associates of the hearing norms for 35 of the 40 words listed. While there was considerable overlap between the deaf students and the hearing norms ($r = .64$), deaf students were more consistent with the hearing norms when responding to exemplars (e.g., WRENCH), while they showed lower likelihood of generating exemplars from category names (e.g., TOOL). In the sentence, "These rodents live in sewers and may have inspired the movie, *Willard,*" deaf students thus would not be as likely as hearing students to connect rodents with rats. They might be equally likely, however, to connect rats with rodents in the sentence, "Rats live in sewers and may have inspired the movie, *Willard.*" Superordinate associations appear to be more accessible for deaf students than subordinate associations, possibly suggesting gaps in hierarchical order.

A high correlation (+.77) between the semantic associates given by hearing and deaf students was reported in a study by McEvoy et al. (1999). Across their "common" concepts, deaf and hearing students thus were qualitatively similar in their responses, despite significant quantitative differences across several measures. In this study of 40 common words, some words appeared to be more familiar than others. Of the category names, UTENSIL was the least familiar, followed by RODENT; only 93 out of 126 deaf students responded to UTENSIL and 94 responded to RODENT. Interestingly, related to the word, RODENT, an equal number of students (30) responded with the same primary associate as the hearing norms (RAT) as circled the word to indicate they did not know it.

While deaf students had stronger overall associations going from exemplars to category names, the word that was least familiar from the two groups was an exemplar. Just 78 students (62%) responded to the word CANARY. Forty-six students circled it as an "unknown" word, 25 gave idiosyncratic responses (one each), and two students responded with each of the following words: BLUE JAY, VEGETABLE, and BOAT. To complete the total number of responses, three students responded with TWEETY. But 34 of the 78 students responded with the primary associate, BIRD, which results in a fairly high strength of .44 (though not nearly as high as the hearing strength of .71).

If category names are retrieved with greater ease than exemplars, that is, if category names are more accessible, what can be learned about this connection to category names that may increase the knowledge and retrieval of exemplars? For deaf students to respond with exemplars given category names, they would need to have a semantic hierarchy in place from which to pull exemplars. This word association task gave an indicator of the hierarchical structure of word meaning. Given the overlap of responses, the lexical structure generally appears to be similar for deaf and hearing students. The differences in the availability of exemplars may be more related to deaf students working with fewer interconnected concepts and less experience with regard to subordinate or other taxonomic relations.

Exemplars are labels for unique members of a category. Deaf children of hearing parents often have fewer verbal labels for objects in the world than hearing children, and deaf children of hearing and deaf parents are less likely to learn these labels through reading (Marschark & Harris, 1996). Deafness in such families or hearing communities allows for fewer incidental learning experiences, which reduces the information that they receive relative to what their hearing peers access through casual conversations, overhearing speech, and reading. Thus, the links between words may not be as strong as with hearing students. The retrieval task in this study required stronger semantic links than what would be required for a recognition task, i.e., multiple choice tests or tasks that provide a context. The more rich and flexible the associative network is related to words, the more resources the individual is able to bring to the reading task (Kretschmer, 1982).

Given these restrictions on language and communication, deaf children may struggle with underdeveloped concepts and fewer verbal labels (Yoshinago-Itano & Downey, 1986). This suggestion is consistent with the present results showing deaf students to be less consistent with the hearing norms when they needed to respond “downward” from the superordinate category if they were to match the “hearing” primary associates which were exemplars. Presented with exemplars, they were more consistent with the hearing norms in responding “upward,” matching the “hearing” primary associates which were category names.

Why might the task of connecting exemplars to category names reveal a stronger connection to the hearing norms than the reverse? Correlations simply describe the relationship; they do not explain why it so. Still, it is suggested that when an exemplar is known, a greater breadth of processing of the category name has been accomplished; the two-way association is successfully connected if one understands an offshoot of a superordinate category since it is once removed. Hence, it may be easier or less semantically taxing to connect, more generally, “upward.” However, to connect a category name to an exemplar, students were asked to “go deeper” without context, and may or may not have the specific connections intact even for categories that are known. It is the difference between being asked to name a major league baseball team (going “downward”), and being asked to name the sport affiliated with the New York Yankees (going “upward”). It is suggested that responses would be more consistent in the latter task (re: subordinate to superordinate) than the former.

Deaf students who use sign language may be more prepared to respond with category names over exemplars because of the nature of sign language. As a conceptual language, categories of signs are learned and used before members of those categories. CAT is learned long before COUGAR or PANTHER or CALICO. And if exposure is limited, exemplars will be limited, also. Therefore, if COUGAR is known to deaf students, CAT is most likely understood as the category. But CAT may be well understood while COUGAR remains unfamiliar. Category members are learned through formal instruction and informal exposure, whereas hearing students have more frequent incidental learning experiences which extend the group of exemplars. Through reading, deaf and hearing students acquire knowledge about the world and its exemplars. Deaf students who do not read as much have a narrower field of knowledge and, hence, fewer links that connect one idea to another. As such, top-down processing during reading becomes less effective, and possibly skews the content to a greater extent. A little bit of knowledge, especially if received through a communication process which is compromised, is a dangerous thing.

Ideas for future research include investigating in greater detail the relationship between reading skill and word associations. This study included both NTID and RIT cross-registered students, but a comparison between the two groups was not made due to the numerous variables involved (i.e., educational background, degree of hearing loss, use of sign language, etc.). Focusing on the technically-oriented RIT environment, a similar study could compare deaf students with hearing RIT students.

The existing data from the deaf students may be analyzed to compare the other exemplars that were given for category names, and the other category names that were given for exemplars, with the hearing norms. Also, a comparison could be made between the number of primary associates given by deaf students that were neither exemplars nor category names with the number of outliers in the hearing norms. The results could further the goal of learning more about the development of semantic connections.

Other areas of interest include the relationship between syntax and vocabulary development, the role of semantic mapping, and the extent to which context may or may not assist deaf students in comprehending text. Ultimately, learning is based on a memory structure that retains connections that are made. Studies related to deaf students and memory would support all areas related to word associations.

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TABLE 1

Mean strength of primary associates (SPA), number of words circled as unfamiliar, number of items left blank, and number of discarded responses (S.D. in parentheses).

OVERALL SPA -- DEAF	OVERALL SPA -- HEARING
.36 (.16)	.44 (.18)
246 unfamiliar = 6.15 (10.25)	*
39 left blank = .97 (1.21)	*
14 discarded = .35 (.62)	*
Category Stimuli	Category Stimuli
.31 (.15)	.41 (.17)
94 unfamiliar = 4.7 (9.7)	*
17 left blank = .85 (.75)	*
6 discarded = .30 (.66)	*
Exemplar Stimuli	Exemplar Stimuli
.41 (.16)	.47 (.20)
152 unfamiliar = 7.6 (10.84)	*
22 left blank = 1.10 (1.55)	*
8 discarded = .40 (.60)	*

*Information not available